

REMARKS

The second Office Action mailed January 16, 2007, and the prior art relied upon therein have been carefully studied. The claims in the application remain as claims 1-18. Applicants again respectfully submit that these claims define novel and unobvious subject matter under Sections 102 and 103, and therefore should be allowed. Favorable reconsideration and allowance are therefore earnestly solicited.

Claims 5 and 8-13 have only been objected to as being dependent on a rejected base claim, and are otherwise indicated as being "allowable if rewritten in independent form... .". Applicants understand that these claims are deemed by the PTO to define novel and unobvious subject matter under Sections 102 and 103, and to otherwise meet all requirements for patentability. Claim 5 has been rewritten in independent form and therefore should now be in condition for formal allowance. Applicants respectfully reserve the right to redraft one or more of claims 8-13 in independent form at a later date.

Claims 1-4, 6, 7 and 14-18 have been rejected as obvious under Section 103 from what is stated to be applicants' admitted prior art (APA) appearing at pages 1-4 of

applicants' specification, in view of JP 57-74334 ("JP '334").
This rejection is respectfully traversed.

Claim 1 of the present application calls for "A piston ring for use with a piston made of an aluminum alloy in an internal combustion engine, comprising a coating film comprising a heat-resistant resin binder material and a solid lubricant dispersed therein on at least one side surface, said heat-resistant resin binder material comprising at least one of a polyamideimide-silicon dioxide hybrid material and a polyamide-silicon dioxide hybrid material".

APA relates to a piston ring of which the side surface is coated with a heat-resistant, wear-resistant resin coating film and a solid lubricant such as molybdenum disulfide, etc., dispersed in the resin which is formed on a phosphate coating or a triiron tetroxide coating provided thereon as an underlayer. However, the piston rings as such are insufficient in durability though they are effective for preventing undesirable aluminum adhesion at the initial stage. Particularly in high-output engines, the resin coating films wear in a relative short period due to high temperatures and collision, bringing the side surfaces of the piston rings into contact with the aluminum alloy ring grooves, thereby causing undesirable aluminum adhesion (see page 2, line 3 to page 3, line 5, of the specification).

APA notes that although much attention has been recently paid to organic-inorganic hybrid materials, which have advantages of both organic and inorganic compounds, polyamideimide-silicon dioxide hybrid materials and polyamide-silicon dioxide hybrid materials are not necessarily satisfactory in aluminum adhesion-preventing effects, despite excellent heat resistance and mechanical strength (see page 4, line 2 to page 5, line 8 of the specification). The paragraph spanning pages 4 and 5 states:

Despite excellent heat resistance and mechanical strength, ... the polyamideimide-silicon dioxide hybrid materials and the polyamide-silicon dioxide hybrid materials are not necessarily satisfactory in aluminum adhesion-preventing effects.

If the PTO is going to rely on what is stated in applicants' specification as APA, the PTO must consider **all** of what is there stated, and applicants respectfully submit that the PTO has not considered, taken into effect, and given effect to the above-quoted paragraph spanning pages 4 and 5 of applicants' specification, because any prior art relied upon must be considered "as a whole", *In re Mercier*, 185 USPQ 774, 778 (CCPA 1975); *In re Wesslau*, 147 USPQ 391, 393 (CCPA 1965); *In re Umbrecht*, 160 USPQ 15, 19 (CCPA 1968).

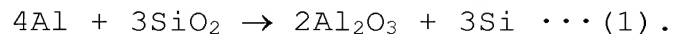
Simply because the polyamideimide-silicon dioxide hybrid material has a moisture absorbent coefficient lower than that of polyamideimide, and simply because polyamide-

silicon dioxide hybrid material has a higher breakage strength and tensile elasticity than polyamide *per se*, both as stated in applicants' specification at page 4 and corresponding to APA, does not mean that these materials could be successfully used in the claimed environment and would provide improved results over the prior art. In this regard, it is well known that Al_2O_3 is more stable than SiO_2 , and it would be expected by those skilled in the art that a hybrid material containing SiO_2 would not prevent aluminum adhesion, but indeed would promote aluminum adhesion.

The practical temperature range of a piston is approximately 200-300°C, and the standard free energy of the formation of SiO_2 is -195 to -185 kcal/mole and that of 2/3 of Al_2O_3 is -245 to -240 kcal/mole at the temperature range as such (see English translation of Fig. 4.2 showing the standard free energy of formation of various kinds of oxides cited from "Revised Third Edition of HANDBOOK OF CHEMISTRY, Applied Section, page 243, edited by the Chemical Society of Japan, and published by Maruzen Kabushiki Kaisha, on August 15, 1980, enclosed herewith).

Thus, when a coating layer of the piston ring containing SiO_2 collides with a piston comprising aluminum alloy at a temperature ranging from 200°C to 300°C, it would be expected by those skilled in the art that the reaction

represented by the following formula (1) might very well take place between the piston ring and the sliding mate ring groove of piston made of the aluminum alloy:



So this reaction usually should leave one skilled in the art in using any one of heat resistant materials **not** containing SiO_2 to prevent the piston ring from aluminum adhesion.

However, the inventors of the present application have found after intensive research that a polyamideimide-silicon dioxide hybrid material and/or a polyamide-silicon dioxide hybrid material produce unexpected effects different from the prediction as mentioned above.

Thus, non-obvious features of the claimed invention are found in that the piston ring in an internal combustion engine comprises a coating film comprising:

(1) **a heat-resistant resin binder material** and **a solid lubricant dispersed therein** on at least one side surface, where

(2) **the heat-resistant resin binder material comprises** at least one of **a polyamideimide-silicon dioxide hybrid material** and **a polyamide-silicon dioxide hybrid material**, thereby making it possible to provide a resin coating film for piston rings with improved heat resistance, mechanical strength and adhesiveness to the piston ring

substrate, and with reduced hygroscopicity and wear rate, thereby **preventing adhesion of aluminum to the side surface** of the piston ring for a long period of time (see page 5, lines 18-22 of the specification).

In contrast to the claimed invention, JP '334 teaches only a sliding material obtained by hot pressing a powder mixture consisting of carbon, amorphous silica and a resin binder in a specified proportion and is silent as to the sliding contact between the sliding material as such and the sliding mate piston **made of the aluminum alloy**, with only a teaching of the sliding contact between the sliding material (6) with the cylindrical mate material (5) made of a glass-fiber reinforced phenol resin (see English translation of page 2, right lower column, lines 1-15 of JP '334 enclosed herewith).

Accordingly, one of ordinary skill in the art referring to APA and JP '334 at the time the present invention was made would not be motivated to reach an idea of a coating film with the distinguished features (1) and (2) of the claimed invention by modifying the teaching of APA with the teaching of JP '334 to prevent the adhesion of aluminum to the side surface of the piston ring for a long period of time. There would have been no reason to even try the materials of APA in the environment of JP '334.

Based on applicants' explanation of the non-obviousness of the present invention as recited in claim 1 over APA in view of JP '334, it should follow that the dependent claims 2-4, 6, 7 and 14-18 also define patentable subject matter over APA in view of JP '334, simply by virtue of the fact that these claims depend from and incorporate the subject matter of claim 1.

Applicants respectfully wish to add a few remarks concerning the dependent portion of claims 2, 4, 6 and 7, which the rejection effectively states may be disregarded as simply "workable or optimum ranges by routine experimentation", based on *In re Aller*, 105 USPQ 233, 235 (CCPA 1955). Applicants respectfully disagree that such ranges must be critical; they need only be unobvious in one way or another, e.g. a non-obvious selection or provide unobvious results.

In this regard, applicants respectfully submit that claims 2, 4, 6 and 7 define non-obvious subject matter not only because they depend from and incorporate the subject matter of claim 1, but also because the recited parameters are not themselves obvious, and in this regard the rejection does not meet the requirements of a *prima facie* case of obviousness as required according to MPEP 2143, i.e. the prior art provides no reason for the selection of the claimed

parameters, there is no reasonable expectation of success, and the prior art relied upon does not disclose the features in question.

As regards claim 2, applicants' specification states as follows at the top of page 9:

When the average particle size of the solid lubricant is less than 0.1 μm , the solid lubricant has poor solid lubrication. When the average particle size is more than 20 μm the solid lubricant is so easily detached from the coating film that the coating film is worn out relatively rapidly.

What an applicant states in his or her specification is to be accepted by the PTO in the absence of evidence or good reasoning to the contrary.

As regards the parameters of claims 4, 6 and 7, applicants' specification states as follows near the bottom of page 10:

When the amount of solid lubricant is less than 5% by mass, the friction coefficient of the coating film cannot be sufficiently reduced, so that the coating film is easily worn. When the amount of the solid lubricant is more than 80% by mass, the heat-resistant material cannot sufficiently hold the solid lubricant,

Again, what an applicant states in his or her specification is to be accepted as accurate by the PTO in the absence of evidence or good reasoning to the contrary.

The PTO acknowledges that the prior art does not disclose the claimed parameters, and the prior art gives no reason to select those parameters. Selecting parameters outside the claimed ranges would result in failure. Applicants' selections give unobviously improved results. Therefore, the conditions under which *In re Aller* is cited do not exist with respect to claims 2, 4, 6 and 7.

Claims 1-4, 6, 7 and 14-18 have also been rejected as obvious under Section 103 from Onoda, previously applied, in view of APA. This rejection is also respectfully traversed.

Onoda teaches a piston ring for preventing aluminum deposition and adhesion thereon including a ring-shaped piston ring main body including upper, lower, outer circumferential surfaces, where an anti-abrasion surface treatment layer is formed on at least the lower surface of the main body, and a polybenzimidazole resin coating film including a solid lubricant, is formed on a surface of the anti-abrasion surface treatment layer (see Abstract of Onoda).

As acknowledged by the PTO, Onoda does not teach or suggest the use of any polybenzimidazole resin coating film including SiO₂ such as a polybenzimidazole-silicon dioxide hybrid material.

It has been pointed out above that there is nothing in APA which would have made it obvious that a silicon dioxide hybrid material would successfully function to prevent aluminum adhesion, and that applicants further believe that those skilled in the art would be more inclined (if they gave the matter any thought at all) to believe that the presence of silicon dioxide would tend to increase rather than decrease adhesion to aluminum.

Accordingly, one of ordinary skill in the art referring APA and Onoda at the time the present invention was made would not be motivated to reach an idea of coating film with the distinguished features (1) and (2) of the claimed invention by modifying the teaching of Onoda with APA to prevent the adhesion of aluminum to the side surface of the piston ring for a long period of time.

Accordingly, claim 1 would not have been made obvious to the person of ordinary skill in the art at the time the present invention was made by consideration together of Onoda and APA. Withdrawal of the rejection is in order and is respectfully requested.

As regards claims 2-4, 6, 7 and 14-18, applicants again respectfully note that these are patentable simply by virtue of the fact that they depend from and incorporate the subject matter of claim 1. Applicants moreover reserve the

right, should it become necessary or desirable to do so, to add additional remarks concerning the non-obviousness of dependent portions of the dependent claims. Moreover, applicants respectfully repeat by reference the commentary made above with regard to claims 2, 4, 6 and 7.

Applicants believe that all issues raised in the Official Action have been addressed above in a manner that should lead to patentability of the present application. Favorable consideration and early formal allowance are respectfully requested.

Respectfully submitted,

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